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CIRCULAR No. 340 FEBRUARY 1935
UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C.

EFFECT OF PARBOILING ROUGH RICE ON MILLING QUALITY

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INTRODUCTION

The most valuable product obtained in the milling of rice is the whole kernels, or head rice. The length and shape of the grain appear to have a direct effect upon the percentage of head rice obtained in milling. The long- and long-slender-grain varieties, as a rule, do not mill so well as do the medium- and short-grain varieties. A high percentage of the rice produced in the United States is of the medium- and short-grain types, largely because of their superior milling quality. However, the milled rice of the better long- and long-slender-grain varieties is quoted on the principal markets at higher prices than that of the medium- and short-grain varieties. If the rough rice of long- and slender-grain varieties could be treated in some manner so that the milling quality would be improved, it might lead to a larger production and consumption of this type of rice in the United States.

In India, Burma, Malaya, Ceylon, and British Guiana (*2, 4, 5, 6, 8*)[1] some of the rough rice is parboiled prior to milling. It is claimed that the parboiled rice mills better and that the milled rice has a more pleasing and distinctive taste, that it contains more vitamin B and is more nourishing than untreated rice.

The process consists of soaking rough rice in either cold, warm, or hot water in cement or metal tanks for 20 to 96 hours. The water is then drained off, and the rice is placed in metal cylinders in which there are one or more perforated steam pipes. Steam is blown into the rice until the hulls open slightly. The parboiled rice is then removed from the cylinders, thoroughly dried in the sun or by artificial means, and milled.

The methods of parboiling vary somewhat in different countries, but the main effects are said to be that: (1) Breakage in the milling

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[1] Italic numbers in parentheses refer to Literature Cited, p. 12.

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process is reduced, (2) the rice is given a distinctive taste or flavor, which is preferred by certain consumers, (3) the rice keeps better before and after cooking than does untreated rice, and (4) people who eat parboiled rice say that it is more sustaining than untreated rice.

The type or types of rice that are parboiled and the exact procedures followed in the countries mentioned are not generally known. A sample of "Superquality Demerara parboiled brown rice" from British Guiana, seen by the writers, was of the long and somewhat slender type similar to Patna. Whether the long- and long-slender-grain types are the only ones parboiled is not known by the writers.

The results of preliminary experiments in parboiling varieties that are grown on a commercial scale in the United States are here reported.

MATERIALS AND METHODS

VARIETIES TREATED

The long-grain varieties Fortuna, Rexoro, Edith, and Iola; the medium-grain variety Blue Rose; and the short-grain varieties Colusa and Caloro were used. These are important commercial varieties in the United States, with the exception of Iola, which has recently been released for commercial testing in Louisiana. Rexoro is a long-slender-grain variety of the same general type as the so-called "Patna" from British India. The more extensive tests were made with Fortuna and Rexoro.

SOAKING

The rough rice was placed in small, loosely woven, white cotton bags. The bags were then submerged in water and kept at room temperature (25° to 30° C.) or controlled temperatures for the desired length of time. The bags were then removed from the water, and the excess water was allowed to drain before the rice was steamed.

STEAMING

The soaked rice was steamed under pressure either in an ordinary autoclave or in a small pressure cooker. In the autoclave, during the steaming, the pressure was from 15 to 17½ pounds, with a temperature range from 121° to 123° C. In the cooker the pressure ranged from 7 to 10 pounds, and the temperature ranged from 111° to 115°. After the rice had been steamed for the desired length of time, it was set to dry in an unheated room. Electric fans were used to circulate the air in the room while the rice was drying. The samples were thoroughly air-dried before they were submitted for shelling tests.

SHELLING TESTS

The parboiled samples and untreated checks of each variety taken from the same sack of rough rice were sent to the Federal-State rice grading office at Crowley, La., for shelling tests,[2] which were made with the Smith shelling device. Smith (*9, p. 11*) states:

> The percentage of whole kernels in a shelling indicates the probable yield of whole kernels or head rice when the lot of rice from which the sample was taken is milled. The yields of Second Head rice, Screenings, and Brewers rice are indicated by the percentages of the broken kernels of these three sizes that are present in the shelling.

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[2] The writers express their appreciation to F. L. Setliff, in charge of the Federal-State rice grading office at Crowley, La., for his kind assistance.

RESULTS

In table 1 are shown data from shelling tests on samples of seven varieties soaked for 24 hours at room temperatures and steamed for different periods. The percentage yield of head rice was materially increased for all varieties steamed 15 and 25 minutes, with the exception of Blue Rose. There was no marked effect from steaming longer than 15 minutes. The samples of Rexoro, Edith, and Iola, steamed only 5 minutes, showed increases ranging from 4.2 percent for Edith to 11.3 percent for Rexoro, whereas the yields of Fortuna and Blue Rose were slightly decreased.

Table 1.—*Effect of length of steaming period on the percentage of head and broken rice obtained from rough rice of different varieties*

[All samples were soaked for 24 hours at room temperatures before being steamed]

Variety	Time steamed	Head rice		Screenings		Brewers		Other broken
		Indicated yield	Increase over check	Indicated yield	Decrease under check	Indicated yield	Decrease under check	
	Minutes	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Fortuna	(1)	68.6		6.8		2.0		1.1
	5	66.6	[2]2.9	8.0	[3]17.6	1.2	40.0	2.2
	15	75.8	10.5	1.3	80.9	.5	75.0	.2
	25	75.3	9.8	1.1	83.8	.5	75.0	.1
Rexoro	(1)	60.1		15.4		9.1		.4
	5	66.9	11.3	9.8	36.4	5.2	42.9	.4
	15	75.3	25.3	1.7	89.0	1.0	89.0	(4)
	25	75.4	25.5	1.4	90.9	.9	90.1	.0
Edith	(1)	57.6		13.6		3.7		3.4
	5	60.0	4.2	12.7	6.6	3.6	2.7	3.1
	15	69.1	20.0	4.6	66.2	1.1	70.3	1.6
	25	71.1	23.4	2.5	81.6	.8	78.4	1.0
Iola	(1)	60.9		15.3		5.8		1.6
	5	64.3	5.6	12.1	20.9	4.0	31.0	1.2
	15	72.6	19.2	4.9	68.0	2.4	58.6	.6
	25	73.0	19.9	4.3	71.9	1.9	67.2	.4
Blue Rose	(1)	73.1		2.4		1.2		2.9
	5	72.7	[2].5	2.4	0	.8	33.3	2.7
	15	72.0	[2]1.5	2.4	0	.7	41.7	3.0
	25	75.0	2.6	1.4	41.7	.6	50.0	1.3
Colusa	(1)	61.7		8.4		2.9		11.2
	45	73.5	19.1	2.4	71.4	1.0	65.5	3.8
Caloro	(1)	62.2		10.8		6.1		6.4
	45	79.6	28.0	.8	92.6	.4	93.4	1.4

[1] Check. [2] Decrease under check. [3] Increase over check. [4] Trace.

The percentages of head rice for the checks of Fortuna and Blue Rose are fairly high. For this reason, large increases in the yields of head rice could not be expected, as from 18 to 22 percent of a sample of rough rice consists of hulls. The yields of head rice for the short-grain Colusa and Caloro varieties were increased 19.1 and 28 percent, respectively, by soaking these varieties 24 hours and steaming them for 45 minutes. These results indicate that short-grain varieties can be hardened and the percentage of head rice materially increased. The samples of Colusa and Caloro used in this test contained some chalky and checked kernels. The parboiling process appeared to harden the checked kernels so that they successfully resisted breakage in the shelling device.

The parboiling process probably is more applicable to long- and long-slender grain varieties than it is to medium-grain varieties, especially if the latter are of good milling quality, such as was the Blue Rose used in this test. This does not mean that the Blue Rose was not hardened by parboiling but merely that, even though the grain was hardened, the percentage of head rice was not materially increased. The average increase in head rice for the 4 long-grain varieties steamed 15 and 25 minutes was 18.9 percent; for the medium-grain variety, Blue Rose, 0.5 percent; and for the 2 short-grain varieties steamed 45 minutes, 23.6 percent.

Shelling tests on samples of Fortuna, Rexoro, and Iola soaked for 48 hours at room temperatures and steamed 30 and 40 minutes, respectively, gave essentially the same results. The average yield of head rice for parboiled samples was: Fortuna, 72.8 percent; Rexoro, 74.1 percent; and Iola, 70 percent; whereas the yield of the checks was: Fortuna, 68.6 percent; Rexoro, 60.1 percent; and Iola, 60.9 percent.

The data presented in table 2 do not show any marked difference in the percentage of head rice from samples soaked for relatively short (23-hour) or long (47-hour) periods at room temperatures and then steamed for 20 or more minutes under like conditions. The samples steamed over a steam bath with no pressure were toughened to some extent but not nearly so much as those that were steamed under pressure. The highest percentages of head rice were obtained from steaming for 35, 45, and 50 minutes.

The samples soaked for only 2 hours at a constant temperature of 70° C. and steamed for 35 minutes gave high percentages of head rice, suggesting that soaking at high temperatures for a relatively short time may be adequate preparation for steaming.

TABLE 2.—*Effect of length of soaking period and time of steaming on the percentage of head and broken rice obtained from Fortuna and Rexoro rice soaked at room temperatures*

Variety	Time		Head rice		Screenings		Brewers		Other broken
	Soaked	Steamed	Indicated yield	Increase over check	Indicated yield	Decrease under check	Indicated yield	Decrease under check	
	Hours	*Minutes*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Fortuna	(1)	--------	51.3	--------	19.9	--------	4.0	--------	4.5
	[2] 2	35	72.6	41.5	3.7	81.4	1.0	75.0	1.1
	23	30	73.2	42.7	3.7	81.4	1.3	67.5	1.1
	25	45	74.0	44.2	3.1	84.4	1.2	70.0	.6
	29	30	72.9	42.1	3.8	80.9	1.1	72.5	1.0
	47	20	73.5	43.3	3.4	82.9	1.0	75.0	.5
	[3] 47	45	63.1	23.0	9.8	50.8	2.0	50.0	2.8
	93	45	58.6	14.2	14.1	29.1	2.7	32.5	4.0
Rexoro	(1)	--------	55.5	--------	19.5	--------	12.3	--------	.8
	[2] 2	35	73.9	33.2	3.4	82.6	1.8	85.4	.2
	25	45	74.3	33.9	2.9	85.1	1.7	86.2	(4)
	45	50	74.5	34.2	2.7	86.2	1.5	87.8	.2

[1] Check. [2] Soaked at 70° C. [3] Steamed over open bath; no pressure. [4] Trace.

SOAKING FOR DIFFERENT PERIODS AT CONSTANT TEMPERATURES

Rough rice was soaked in water at temperatures which were kept constant within ±1° C.

Samples of Fortuna and Rexoro were soaked for 12, 18, 24, and 30 hours at temperatures of 40°, 50°, 60°, and 70° C. Soaking at a temperature of 80° for 1, 2, 3, and 12 hours was also tried. The samples soaked 1, 2, and 3 hours at 80° did not become soggy and sticky, whereas those soaked for 12 hours did. After being soaked, the samples were divided, and one part was steamed for 20 minutes and the other for 35 minutes.

The shelling results from these treatments did not indicate that soaking for more than 12 hours had any particular advantage or disadvantage at any of the temperatures used up to 70° C. Likewise, the percentage of head rice appeared to be about the same whether the steaming was for 20 or for 35 minutes.

Figure 1 shows the effect of water temperature and length of soaking period on the average percentage of head rice for the samples steamed 20 and 35 minutes.

The writers believe that the larger variations shown in figure 1, such as the drop in the average percentage of head rice for both varieties when soaked at 50° C. and the marked reduction in the average percentage of head rice for Rexoro soaked 18 and 24 hours at 70°, are due to causes other than the processing treatment. There is some evidence in the data indicating that Rexoro, which has a slender grain, may not require so long a steaming period as Fortuna, which has a somewhat thicker and heavier kernel. Figure 1 shows that a very short soaking period (from 1 to 3 hours), at 80°, gave fairly good results.

Figure 2 shows the average effect of length of soaking period at 40, 50, 60, and 70° C. and steaming for 20 and for 35 minutes on the percentage of head rice. Both varieties gave nearly the same average percentage of head rice for all soaking periods, indicating that there was no distinct advantage in soaking for more than 12 hours.

Figure 3 shows the effect of length of steaming period on the average percentage of head rice obtained after it had been soaked at constant temperatures for 12, 18, 24, and 30 hours and steamed for 20 and 35 minutes, respectively. The percentage of head rice for both varieties was essentially the same when steamed for 20 and for 35 minutes.

Figure 4 shows the effect of water temperature on the average percentage of head rice from samples soaked for 12, 18, 24, and 30 hours at 50°, 60°, and 70° C., and for 2 and 3 hours at 80°. These samples were not steamed after being soaked. The average increases in yield of head rice for Fortuna soaked at 70° and 80° were 9.6 and 13.5 percent, respectively. The average increases in head rice of Rexoro soaked at 60°, 70°, and 80° were 7.1, 13.1, and 11.9 percent, respectively. There was a marked decrease in the percentage of screenings and brewers rice as the percentage of head rice increased.

The results indicate a partial gelatinization of the starch of Fortuna at 70° and 80° C., and of Rexoro at 60°, 70°, and 80° C. Rice starch begins to gelatinize at temperatures varying from 60° to 75° C. The increase in the average percentage of head rice resulting from soaking at the higher temperatures is probably due, therefore, to a partial gelatinization of the starch.

In table 3 are shown the average percentages of head and broken rice in 8 samples of Fortuna and Rexoro soaked 12, 18, 24, and 30 hours at constant temperatures and steamed 20 and 35 minutes. At each temperature the average percentages were obtained from 16 shelling tests. The rice at 80° C. was soaked 1, 2, and 3 hours,

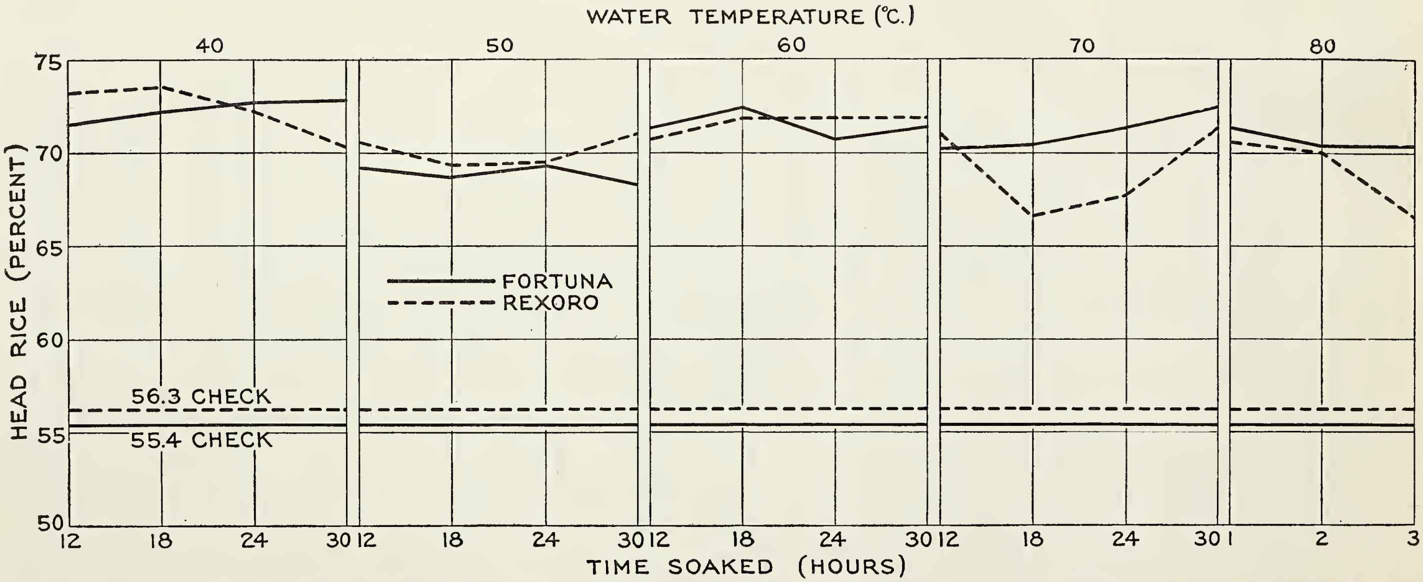

FIGURE 1.—Effect of water temperature and length of soaking period on the average percentage of head rice for samples steamed 20 and 35 minutes (check=untreated).

and single samples were steamed for 35 minutes. The results at this temperature are each averages of three shelling tests.

TABLE 3.—*Average percentage of head, screenings, and brewers rice obtained from Fortuna and Rexoro rice soaked 12, 18, 24, and 30 hours at constant temperatures and steamed 20 and 35 minutes.*

Variety	Temperature	Head rice		Screenings		Brewers	
		Indicated yield	Increase over check	Indicated yield	Decrease under check	Indicated yield	Decrease under check
	° *C.*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Fortuna	(1)	55. 4	----------	18. 6	----------	3. 1	----------
	40	77. 2	39. 3	4. 4	76. 3	1. 3	58. 1
	50	68. 8	24. 2	7. 6	59. 1	1. 9	38. 7
	60	71. 5	29. 1	5. 8	68. 8	1. 6	48. 4
	70	71. 1	28. 3	6. 3	66. 1	1. 8	41. 9
	[2] 80	70. 7	27. 6	7. 1	61. 8	2. 3	25. 8
Average for treated rice	----------	71. 9	29. 7	6. 2	66. 7	1. 8	41. 9
Rexoro	(1)	56. 3	----------	20. 2	----------	15. 4	----------
	40	72. 4	28. 6	4. 9	75. 7	3. 6	76. 6
	50	70. 1	24. 5	7. 3	63. 9	5. 6	63. 6
	60	71. 6	27. 2	6. 5	67. 8	4. 9	68. 2
	70	69. 2	22. 9	8. 6	57. 5	7. 1	53. 9
	[2] 80	69. 0	22. 6	8. 2	59. 4	6. 5	57. 8
Average for treated rice	----------	70. 5	25. 2	7. 1	64. 9	5. 5	64. 3

(1) Check.

[2] Soaked 1, 2, and 3 hours.

The average increase in head rice for Fortuna ranged from 24.2 to 39.3 percent and for Rexoro from 22.6 to 28.6 percent. The average increase in head rice in the 67 samples of Fortuna soaked at constant temperatures and steamed 20 and 35 minutes was 29.7 percent and in Rexoro 25.2 percent.

The average decreases in screenings and brewers rice with Fortuna were 66.7 and 41.9 percent and with Rexoro, 64.9 and 64.3 percent, respectively.

Fortuna is said to be of prime milling quality when the indicated yield is 46.3 percent, or 75 pounds of head rice per barrel. The Fortuna used in the experiment on the effect of soaking at constant temperatures had an indicated yield of 89.7 pounds per barrel, or 55.4 percent of head rice. The effects of parboiling in this case were, therefore, obtained on Fortuna of prime milling quality. The same probably is true of the Rexoro, as the indicated yield of head rice for the checks was 56.3 percent, or 91.2 pounds per barrel. The increase in yield of head rice from parboiling rice of lower indicated milling quality should be greater.

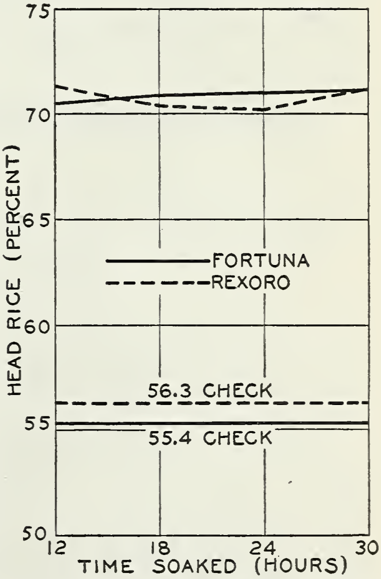

FIGURE 2.—Effect of length of soaking period on the average percentage of head rice (check = untreated).

COLOR

Ordinary milled rice is white and more or less opaque, whereas the parboiled milled rice obtained in these experiments varied from nearly translucent to amber. The change in color from white to amber appears to be associated with the temperature of the water and the length of the soaking period, the duration of the steaming period and the temperature maintained during that period, and the color of the hull of the rough rice.

Rice soaked for relatively short periods at room temperatures and at temperatures up to 50° C. showed little change in color, whereas that soaked at 60°, and above, changed to amber of various shades. In all varieties the rice steamed long periods was of a darker amber than that steamed short periods. The hull of Rexoro is golden-colored and that of Fortuna straw-colored. The parboiled Rexoro rice was always slightly darker in color than that of Fortuna. The kernel may absorb some color from the hulls during the soaking and steaming periods. The color of nearly all the parboiled milled samples of Rexoro and Fortuna was lighter than that of the sample from British Guiana labeled "Superquality Demerara parboiled brown rice."

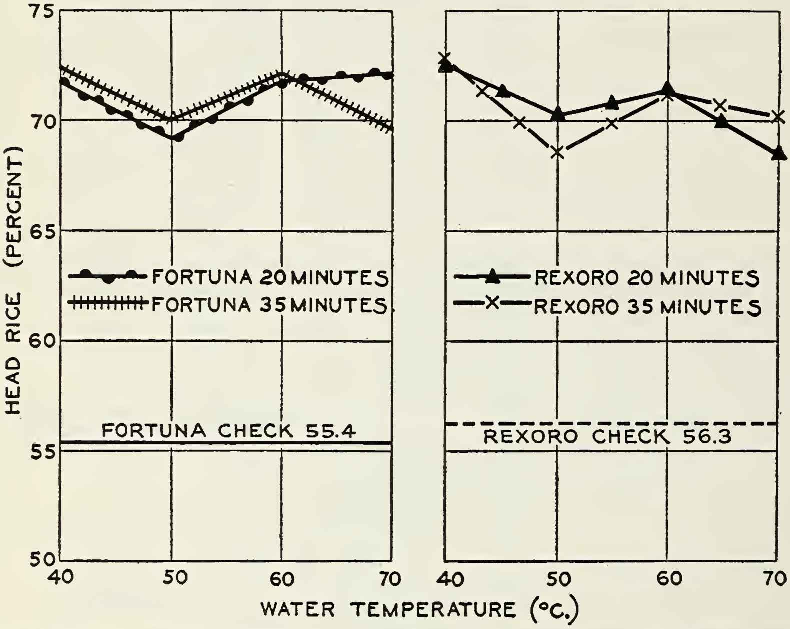

FIGURE 3.—Effect of length of steaming period on the average percentage of head rice (check=untreated)

In steaming the rice in an autoclave, it was observed that those grains that remained in contact with the hot metal were often overheated and darker than those not so placed. It appears, therefore, that a product more uniform in color and texture might be obtained if the rice were placed in a partly filled fine-mesh metal cylinder that would rotate inside a retort as the rice is steamed. In this way the rice would be kept in motion, and all grains would receive equal treatment. The kernels from which the hulls have been removed also are overheated because they are not protected by the hulls. These kernels become dark amber in color. When thoroughly dried, the kernels of processed rice are translucent and hard. Even though the parboiled milled rice is darker than untreated rice, it is nearly as white when boiled.

DISCUSSION

The average increase of about 25 percent in the yield of head rice from parboiled samples of Fortuna and Rexoro suggests the possibility of treating these varieties on a commercial scale, since the increase in head rice, combined with other desirable characteristics, appears to be of sufficient importance to fully justify the treatment.

In the process of parboiling, the starch grains in the kernels are apparently gelatinized, and, being protected by the hull and seed coats, the kernels retain their original shape. When the grains have been thoroughly steamed the hulls begin to separate. The kernels now consist of a gelatinous elastic starch which, upon drying, becomes translucent and very hard. These kernels react quite differently in cooking from untreated kernels that contain a large number of individual starch grains. Since dry starch cannot be gelatinized, it is first necessary to soak the rice. When well soaked the starch grains can be gelatinized by heat. The most desirable heat appears to be steam, because dry heat reduces the moisture of the rice so quickly that the starch cannot be satisfactorily gelatinized.

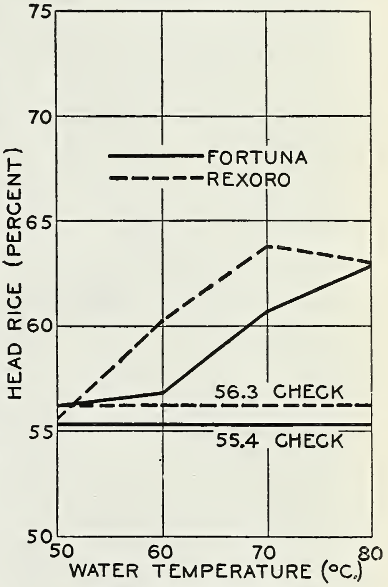

Figure 4.—Effect of water temperature on the average percentage of head rice (check= untreated).

In parboiling rice, the length of the soaking period, the temperature of the water in which the rice is soaked, the length of the steaming period, and the pressure of the steam used apparently vary in different countries and probably also in the same country. The results of the writers' experiments and the methods mentioned in the literature indicate that rice can be parboiled with fair success by slight variations in the treatment, the essential features of which are, after all, much alike.

In Burma, rough rice is soaked in cold or hot water, and Charlton (*2*) states that opinion differs as to which gives parboiled rice with the least discoloration. The soaking period is shortened by using hot water, and in busy times hot water is used by nearly all millers who parboil rice. Foul odors, due to the development of putrefactive bacteria in the soaking tanks, are more or less common and objectionable during poor drying weather in Burma. These odors can be eliminated by either acidifying the water or by using hot water, 60° C.

or above. The latter method is recommended by Charlton (*2*). He also gives the minimum length of soaking for good results as 3 days at 35° and 45°, 21 hours at 55°, 12 hours at 60°, and 9 hours at 70° and 80°. In the writers' experiments, satisfactory results were obtained with rice soaked 12, 18, 24, and 30 hours at 40° and 50°, although there were a few kernels with white bellies in the lots soaked only 12 and 18 hours. Soaking for 12 hours at 60° and 70° seemed sufficient, although longer periods, up to 30 hours, did no particular harm. Rice soaked from 1 to 3 hours at 80° was of normal texture, but that soaked for 12 hours was soggy and sticky.

In most of the writers' work, the rice was steamed 20 or 35 minutes, whereas, in other countries, the rice is said to be steamed from 10 to 15 minutes.

The Josh (boiling) method, as described by Ishaq (*7*), is similar in some respects to parboiling, but the rice is not steamed. This method undoubtedly is less effective than parboiling in hardening the rice, but it evidently is beneficial. In the writers' tests, rough rice soaked at high temperatures and dried without steaming gave fair increases in the percentage of head rice.

In chemical analyses of parboiled and untreated (raw) rice Codd and Peterkin (*3, pp. 25–26*) show that the phosphate content of parboiled rice is higher than that of raw rice. They also say:

> As a rule, the occurrence of the antineuritic vitamin B_1 is proportional to the amount of phosphate present, but Aykroyd's results show that this is not the case in parboiled rice. Apparently, the process of parboiling causes this vitamin (and a certain amount of phosphate) to percolate into the grain and it is not removed by milling; so that not only does parboiled rice contain more phosphate than raw rice, but the vitamin content of parboiled rice is even higher than would be expected from the phosphate content.

In summarizing his work Aykroyd (*1, p. 192*) says:

> Highly milled parboiled rice was found to be rich in the antineuritic vitamin B_1, while roughly milled raw rice was deficient * * *. Exact comparison was made of the vitamin B_1 potency of two samples of rice, the one raw, the other parboiled, after similar degrees of milling. The vitamin value of the unmilled samples was equal, but when each was highly milled to an equal degree, as judged by weight of polishings removed in a hand rice mill, the parboiled sample retained its vitamin while the raw sample did not. * * * Parboiled rice contains more P_2O_5 than raw rice milled to the same degree. It is probable that when rice is steamed in the process of parboiling, the vitamin B_1 and some of the phosphate contained in the germ and pericarp diffuse through the endosperm.

By using methods and equipment well suited for parboiling rice, a more uniform product of better color and texture probably could be obtained. Many of the samples of parboiled milled rice obtained in the writers' experiments were only slightly darker than those of untreated milled rice, yet they appeared to be thoroughly parboiled. As stated, parboiled rice is darker than untreated milled rice, but it is nearly as white when boiled.

In the boiled samples the parboiled kernels retained their shape and also resisted disintegration in sterilization in canned soup much better than did the untreated kernels of the same variety (figs. 5 and 6).

A considerable quantity of the so-called "Patna" rice grown in India is imported duty-free each year, largely from the Netherlands, for use in commercially canned soups. In canned soups a rice is desired that after processing has a firm whole kernel. In the past, American-

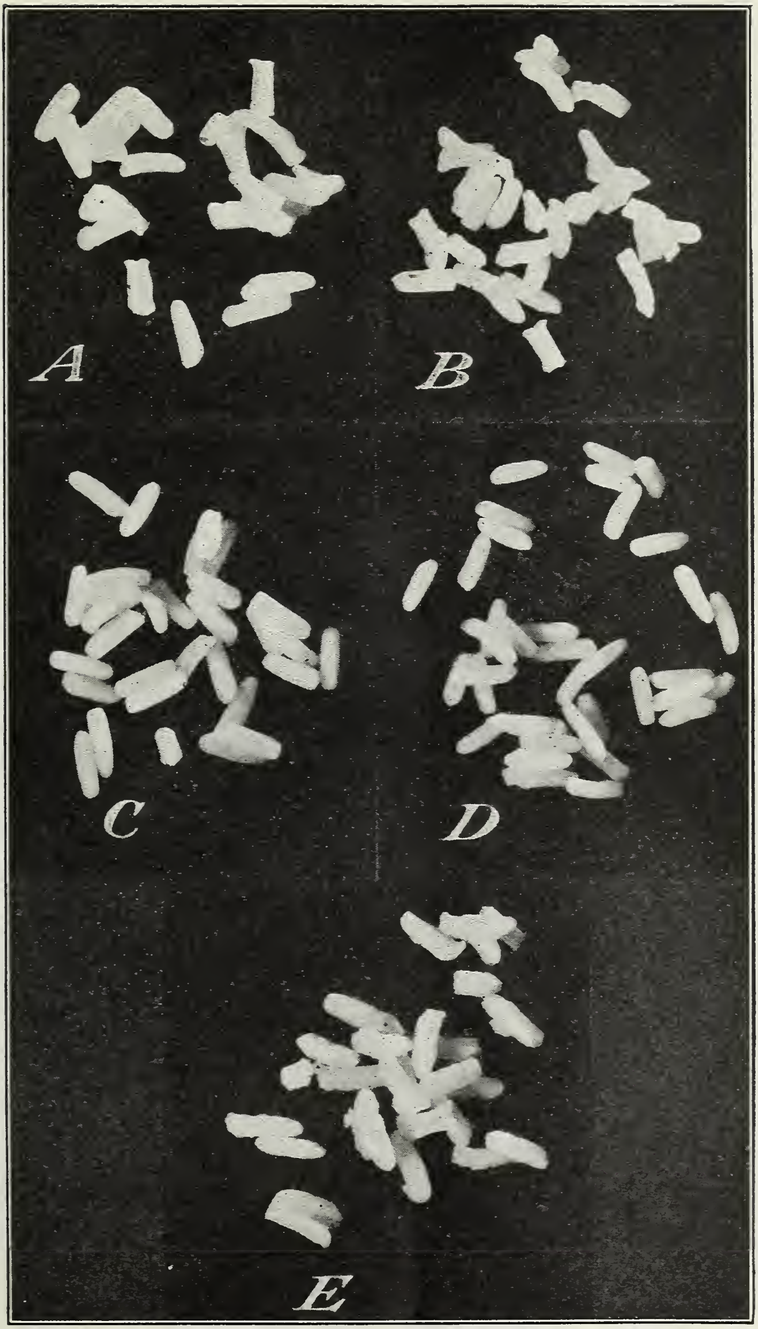

FIGURE 5.—Samples of boiled rice: *A*, Fortuna untreated; *B*, Rexoro untreated; *C*, Fortuna parboiled; *D*, Rexoro parboiled; *E*, Patna.

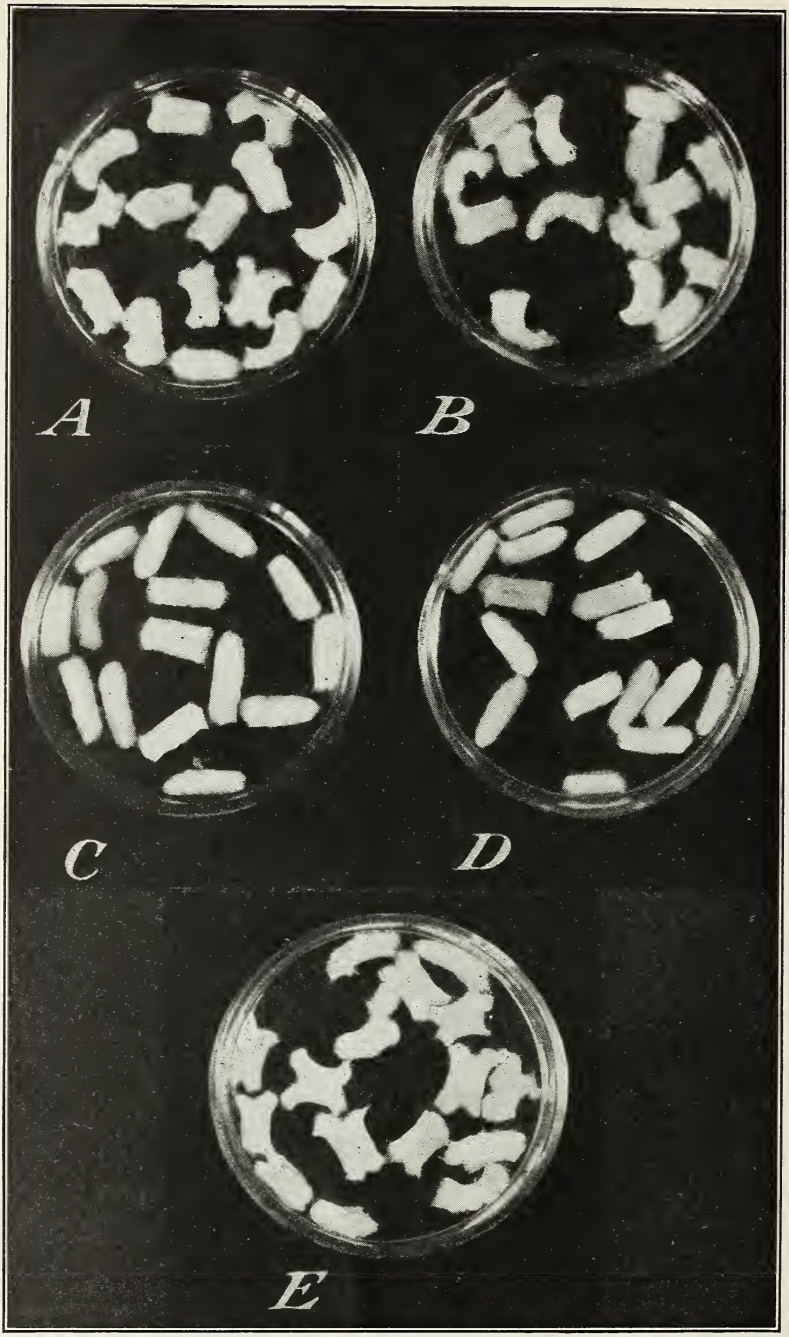

FIGURE 6.—Samples of boiled and sterilized rice: *A*, Fortuna untreated; *B*, Rexoro untreated; *C*, Fortuna parboiled; *D*, Rexoro parboiled; *E*, Patna.

grown varieties that have been compared with Patna in canned soups have not been found so satisfactory.

Whether the imported Patna rice is treated before being milled to improve its quality has not been determined. Its qualities suggest that it probably is. In comparing parboiled Fortuna and Rexoro rices with imported Patna, it is evident that the two former have all the desirable characteristics of the latter so far as ordinary boiling is concerned, and that they are even more desirable for use in canned products.

The available evidence shows that parboiled rice has desirable characteristics that are at present entirely unknown in the rice trade of the United States. Suitable equipment for parboiling rice on a commercial scale probably is now available or can easily be designed in this country. The consumption of rice in the United States very probably could be materially increased by supplying the market with high-quality parboiled rice, which, according to all the evidence, is better in cooking quality and in flavor. Douglas (*6*) says:

> It is well worth consideration whether the best quality of parboiled rice could not be introduced into Great Britain. As a domestic rice it is entirely unknown at home, and yet it presents many excellent features. It keeps well, it seems practically as white as our white rice does when cooked; it has an agreeable flavor and it is undoubtedly more nourishing than the highly finished and artificially glazed and coated rices of commerce. It is, after all, in universal use among the white or European population of the West Indies in general; and not only so, it is actually preferred by them to the less nourishing and more expensively milled white rice.

SUMMARY

The average increase in head rice in samples soaked 24 hours at room temperatures and steamed 15 and 25 minutes was: Fortuna, 10.2 percent; Rexoro, 25.4 percent; Edith, 21.7 percent; Iola, 19.6 percent; Blue Rose, 0.6 percent; and in Colusa and Caloro, steamed 45 minutes, 19.1 and 28.0 percent, respectively.

The highest increase in head rice was 44.2 percent in a sample of Fortuna soaked 25 hours at room temperature and steamed 45 minutes, and it was 34.2 percent in a sample of Rexoro soaked 45 hours at room temperature and steamed 50 minutes.

The increases in head rice as a result of parboiling were essentially the same regardless of the length of the soaking period, the temperature of the water in which the rice was soaked, or the length of the period of steaming. The color and texture of the parboiled milled rice were, however, affected by these factors.

The average increase in head rice in all Fortuna samples soaked at constant temperatures for various lengths of time and steamed 20 and 35 minutes was 29.7 percent and in all Rexoro samples 25.2 percent.

Parboiled milled rice retains its shape better when boiled and when sterilized in containers after being boiled than does untreated rice of the same varieties.

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U. S. GOVERNMENT PRINTING OFFICE: 1935

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